

PROCEEDINGS OF SPIE

Advances in X-Ray/EUV Optics and Components VIII

Ali Khounsary
Shunji Goto
Christian Morawe
Editors

26–28 August 2013
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 8848

Proceedings of SPIE 0277-786X, V. 8848

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Advances in X-Ray/EUV Optics and Components VIII, edited by Ali Khounsary,
Shunji Goto, Christian Morawe, Proc. of SPIE Vol. 8848, 884801 · © 2013 SPIE
CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2048408

Proc. of SPIE Vol. 8848 884801-1

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Advances in X-Ray/EUV Optics and Components VIII*, edited by Ali Khounsary, Shunji Goto, Christian Morawe, Proceedings of SPIE Vol. 8848 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819496980

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2013, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/13/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.



SPIEDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

ix Conference Committee

SESSION 1 NOVEL DEVELOPMENTS

- 8848 02 **Two-dimensional sub-5-nm hard x-ray focusing with MZP** [8848-1]
M. Osterhoff, M. Bartels, F. Döring, C. Eberl, Georg-August-Univ. Göttingen (Germany);
T. Hoinkes, Vienna Ctr. for Quantum Science and Technology (Austria); S. Hoffmann,
T. Liese, V. Radisch, Georg-August-Univ. Göttingen (Germany); A. Rauschenbeutel, Vienna
Ctr. for Quantum Science and Technology (Austria); A.-L. Robisch, A. Ruhlandt,
F. Schlenkrich, T. Salditt, H.-U. Krebs, Georg-August-Univ. Göttingen (Germany)
- 8848 04 **Thin crystal development and applications for hard x-ray free-electron lasers** [8848-3]
T. Osaka, Osaka Univ. (Japan); M. Yabashi, RIKEN SPring-8 Ctr. (Japan); Y. Sano, Osaka
Univ. (Japan); K. Tono, Japan Synchrotron Radiation Research Institute (Japan);
Y. Inubushi, RIKEN SPring-8 Ctr. (Japan); T. Sato, RIKEN SPring-8 Ctr. (Japan) and The Univ. of
Tokyo (Japan); K. Ogawa, RIKEN SPring-8 Ctr. (Japan); S. Matsuyama, Osaka Univ. (Japan)
and Japan Science and Technology Agency, CREST (Japan); T. Ishikawa, RIKEN SPring-8
Ctr. (Japan); K. Yamauchi, Osaka Univ. (Japan) and Japan Science and Technology
Agency, CREST (Japan)
- 8848 05 **Design of novel x-ray optical system for rocket experiment** [8848-4]
L. Pina, Czech Technical Univ. in Prague (Czech Republic); R. Hudec, Czech Technical
Univ. in Prague (Czech Republic) and Astronomical Institute, Academy of Sciences of the
ASCR, v.v.i. (Czech Republic); V. Tichy, Czech Technical Univ. in Prague (Czech Republic);
A. Inneman, D. Cerna, Rigaku Innovative Technologies Europe (Czech Republic); L. Sveda,
Czech Technical Univ. in Prague (Czech Republic); J. Marsik, V. Marsikova, Rigaku
Innovative Technologies Europe (Czech Republic); W. Cash, A. F. Shipley, B. R. Zeiger,
T. D. Rogers, Univ. of Colorado at Boulder (United States)
- 8848 06 **High-speed photon energy tuning of x-rays with high duty cycle by use of Clessidra prism
arrays** [8848-5]
W. Jark, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); A. Last, O. Márkus, Karlsruher Institut für
Technologie (Germany)

SESSION 2 FOCUSING TECHNIQUES

- 8848 07 **Hard x-ray nanofocusing with refractive x-ray optics: full beam characterization by
ptychographic imaging** [8848-6]
C. G. Schroer, F.-E. Brack, R. Brendler, S. Höning, R. Hoppe, J. Patommel, S. Ritter, M. Scholz,
A. Schropp, F. Seiboth, Technische Univ. Dresden (Germany); D. Nilsson, J. Rahomäki,
F. Uhlén, U. Vogt, KTH Royal Institute of Technology (Sweden); J. Reinhardt, G. Falkenberg,
DESY (Germany)

- 8848 08 **X-ray tomography of high pressure fuel spray by polycapillary optics** [8848-7]
L. Marchitto, Istituto Motori, CNR (Italy); S. B. Dabagov, INFN, Lab. Nazionali Frascati (Italy) and P.N. Lebedev Physical Institute (Russian Federation); L. Allocca, Istituto Motori, CNR (Italy); D. Hampai, INFN, Lab. Nazionali Frascati (Italy); A. Liedl, Univ. degli Studi di Roma La Sapienza (Italy); S. Alfuso, Istituto Motori, CNR (Italy)
- 8848 09 **Sagittal focusing inducing energy structure in medium to high energy resolution x-ray monochromators** [8848-8]
M. G. Hönnicke, Univ. Federal da Integracao Latino-Americana (Brazil); F. Masiello, PANalytical B.V. (France); S. N. Ehrlich, Brookhaven National Lab. (United States); E. M. Kakuno, Univ. Federal do Pampa (Brazil); Y. Q. Cai, Brookhaven National Lab. (United States); J. Härtwig, European Synchrotron Radiation Facility (France)
- 8848 0A **Aberrations in saw-tooth refractive lenses in short focal length x-ray focusing** [8848-9]
M. A. Antimonov, Univ. of Illinois at Chicago (United States) and Argonne National Lab. (United States); A. M. Khounsary, S. D. Shastri, Argonne National Lab. (United States)

SESSION 3 X-RAY MIRRORS

- 8848 0B **K-B bendable system optimization at FERMI@Elettra FEL: impact of different spatial wavelengths on the spot size** [8848-10]
L. Raimondi, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); C. Svetina, Elettra-Sincrotrone Trieste S.C.p.A. (Italy) and Univ. of Trieste (Italy); N. Mahne, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); D. Cocco, SLAC National Accelerator Lab. (United States); F. Capotondi, E. Pedersoli, M. Kiskinova, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); B. Keitel, G. Brenner E. Plörjes, DESY (Germany); T. Mey, K. Mann, Laser-Lab. Gottingen e.V. (Germany); M. Zangrando, Elettra-Sincrotrone Trieste S.C.p.A. (Italy) and CNR, Istituto per l'Officina dei Materiali (Italy)
- 8848 0C **Development of a numerically controlled elastic emission machining system for fabricating mandrels of ellipsoidal focusing mirrors used in soft x-ray microscopy** [8848-11]
Y. Takei, T. Kume, H. Motoyama, The Univ. of Tokyo (Japan); K. Hiraguri, H. Hashizume, Natsume Optical Corp. (Japan); H. Mimura, The Univ. of Tokyo (Japan)
- 8848 0D **Two-foci bendable mirrors for the ALS MAESTRO beamline: design and metrology characterization and optimal tuning of the mirror benders** [8848-12]
N. A. Artemiev, K. P. Chow, D. J. Merthe, E. Rotenberg, J. H. Takakuwa, T. Warwick, V. V. Yashchuk, Lawrence Berkeley National Lab. (United States)
- 8848 0E **Optical design of soft x-ray focusing system with ellipsoidal mirror for laboratory-based sources** [8848-13]
H. Motoyama, T. Saito, H. Mimura, The Univ. of Tokyo (Japan)
- 8848 0F **Compound focusing for hard-x-ray inelastic scattering** [8848-14]
D. Ishikawa, H. Uchiyama, Japan Synchrotron Radiation Research Institute (Japan) and RIKEN SPring-8 Ctr. (Japan); S. Tsutsui, Japan Synchrotron Radiation Research Institute (Japan); H. Fukui, RIKEN SPring-8 Ctr. (Japan) and Univ. of Hyogo (Japan); A. Q. R. Baron, Japan Synchrotron Radiation Research Institute (Japan) and RIKEN SPring-8 Ctr. (Japan)

SESSION 4 METROLOGY

- 8848 0G **X-ray mirror metrology using SCOTS/deflectometry** [8848-15]
R. Huang, P. Su, J. H. Burge, College of Optical Sciences, The Univ. of Arizona (United States); M. Idir, Brookhaven National Lab. (United States)
- 8848 0H **Application of time-invariant linear filter approximation to parametrization of one- and two-dimensional surface metrology with high quality x-ray optics** [8848-16]
V. V. Yashchuk, Lawrence Berkeley National Lab. (United States); Y. N. Tyurin, Moscow State Univ. (Russian Federation) and Second Star Algonumerics (United States); A. Y. Tyurina, Scientific Systems Co., Inc. (United States)
- 8848 0I **Correlation analysis of surface slope metrology measurements of high quality x-ray optics** [8848-17]
V. V. Yashchuk, N. A. Artemiev, I. Lacey, D. J. Merthe, Lawrence Berkeley National Lab. (United States)
- 8848 0K **Error compensation for the calibration of mechanical mirror benders** [8848-34]
J. Nicolas, CELLS - ALBA (Spain); J. Campos, Univ. Autònoma de Barcelona (Spain)
- 8848 0L **Status of multi-beam long trace-profiler development** [8848-19]
M. V. Gubarev, NASA Marshall Space Flight Ctr. (United States); D. J. Merthe, Lawrence Berkeley National Lab. (United States); K. Kilaru, T. Kester, B. Ramsey, NASA Marshall Space Flight Ctr. (United States); W. R. McKinney, Lawrence Berkeley National Lab. (United States); P. Z. Takacs, Brookhaven National Lab. (United States); A. Dahir, Texas A&M Univ.-Commerce (United States); V. V. Yashchuk, Lawrence Berkeley National Lab. (United States)

SESSION 5 MULTILAYER COATING

- 8848 0N **Suppression of long wavelength reflection from extreme-UV multilayer optics** [8848-21]
Q. Huang, A. J. R. van den Boogaard, R. van de Kruis, E. Zoethout, V. V. Medvedev, FOM Institute DIFFER (Netherlands); E. Louis, F. Bijkerk, FOM Institute DIFFER (Netherlands) and Univ. Twente (Netherlands)
- 8848 0O **Optimization of LaN/B multilayer mirrors for 6.x nm wavelength** [8848-22]
I. A. Makhotkin, R. W. E. van de Kruis, E. Zoethout, FOM Institute DIFFER (Netherlands); E. Louis, F. Bijkerk, FOM Institute DIFFER (Netherlands) and Univ. Twente (Netherlands)

SESSION 6 XFEL AND MISCELLANEOUS APPLICATIONS

- 8848 0Q **Fabrication of x-ray gratings by direct write maskless lithography** [8848-24]
D. L. Voronov, Lawrence Berkeley National Lab. (United States); S. Diez, Heidelberg Instruments GmbH (Germany); P. Lum, Univ. of California, Berkeley (United States); S. A. Hidalgo, T. Warwick, N. Artemiev, H. A. Padmore, Lawrence Berkeley National Lab. (United States)

- 8848 OS **Damage characteristics of platinum/carbon multilayers under x-ray free-electron laser irradiation** [8848-26]
J. Kim, Osaka Univ. (Japan); T. Koyama, H. Yumoto, Japan Synchrotron Radiation Research Institute/SPring-8 Ctr. (Japan); A. Nagahira, Osaka Univ. (Japan); S. Matsuyama, Osaka Univ. (Japan) and Japan Science and Technology Agency, CREST (Japan); Y. Sano, Osaka Univ. (Japan); M. Yabashi, RIKEN SPring-8 Ctr. (Japan); H. Ohashi, Japan Synchrotron Radiation Research Institute/SPring-8 Ctr. (Japan) and RIKEN SPring-8 Ctr. (Japan); T. Ishikawa, RIKEN SPring-8 Ctr. (Japan); K. Yamauchi, Osaka Univ. (Japan) and Japan Science and Technology Agency, CREST (Japan)
- 8848 OT **Damage threshold investigation using grazing incidence irradiation by hard x-ray free electron laser** [8848-27]
T. Koyama, H. Yumoto, K. Tono, Japan Synchrotron Radiation Research Institute (Japan); T. Sato, RIKEN SPring-8 Ctr. (Japan); T. Togashi, Japan Synchrotron Radiation Research Institute (Japan); Y. Inubushi, RIKEN SPring-8 Ctr. (Japan); T. Katayama, Japan Synchrotron Radiation Research Institute (Japan); J. Kim, S. Matsuyama, Osaka Univ. (Japan); H. Mimura, The Univ. of Tokyo (Japan); M. Yabashi, RIKEN SPring-8 Ctr. (Japan); K. Yamauchi, Osaka Univ. (Japan); H. Ohashi, Japan Synchrotron Radiation Research Institute (Japan)
- 8848 OU **Process-induced inhomogeneities in higher asymmetry angle x-ray monochromators** [8848-28]
D. Korytár, Institute of Electrical Engineering (Slovakia); P. Vagovič, Tohoku Univ. (Japan); C. Ferrari, CNR, Istituto Materiali per Elettronica e Magnetismo (Italy); P. Šiffalovič, M. Jergel, Institute of Physics (Slovakia); E. Dobročka, Z. Zápražný, Institute of Electrical Engineering (Slovakia); V. Áč, Alexander Dubček Univ. of Trenčín (Slovakia); P. Mikulík, Masaryk Univ. (Czech Republic)

POSTER SESSION

- 8848 0W **Using organic slab to obtain x-ray tube spectra for quantitative analysis of x-ray fluorescence analysis** [8848-30]
S. Liu, Q. Li, Shanghai Institute of Optics and Fine Mechanics (China)
- 8848 0Y **Multilevel stacked Fresnel zone plate for hard x-rays** [8848-32]
L. Haroutunyan, Yerevan State Univ. (Armenia); K. Trouni, Candle Synchrotron Research Institute (Armenia); A. Kuyumchyan, American NanoScience and Advanced Medical Equipment, Inc. (United States)
- 8848 0Z **The Alba ray tracing code: ART** [8848-33]
J. Nicolas, CELLS - ALBA (Spain); A. Barla, CNR, Istituto di Struttura della Materia (Italy); J. Juanhuix, CELLS - ALBA (Spain)
- 8848 10 **Modulation of intensity in defocused beams** [8848-35]
J. Nicolas, G. García, CELLS - ALBA (Spain)
- 8848 11 **Optimization of the soft x-ray transmission microscopy beamline at the ALBA light source** [8848-36]
A. Sorrentino, E. Pereiro, R. Valcárcel, S. Ferrer, J. Nicolas, CELLS - ALBA (Spain)

- 8848 12 **Development of an objective flat-field spectrograph for electron microscopic soft x-ray emission spectrometry in 50-4000 eV** [8848-37]
T. Imazono, M. Koike, T. Kawachi, N. Hasegawa, Japan Atomic Energy Agency (Japan);
M. Koeda, T. Nagano, H. Sasai, Y. Oue, Z. Yonezawa, S. Kuramoto, Shimadzu Corp.
(Japan); M. Terauchi, Tohoku Univ. (Japan); H. Takahashi, N. Handa, T. Murano, JEOL Ltd.
(Japan)
- 8848 13 **Investigation of high thermal contact conductance at low contact pressure for high-heat-load optical elements of synchrotron radiation** [8848-38]
T. Takeuchi, M. Tanaka, H. Ohashi, S. Goto, Japan Synchrotron Radiation Research Institute
(Japan)
- 8848 14 **Engineering optical constants for broadband single layer antireflection coatings** [8848-39]
S. P. Huber, R. W. E. van de Kruijjs, A. E. Yakshin, E. Zoethout, FOM Institute DIFFER
(Netherlands); F. Bijkerk, FOM Institute DIFFER (Netherlands) and Univ. Twente (Netherlands)

Author Index

Conference Committee

Program Track Chair

Carolyn A. MacDonald, University at Albany (United States)

Conference Chairs

Ali Khounsary, Argonne National Laboratory (United States)

Shunji Goto, Japan Synchrotron Radiation Research Institute (Japan)

Christian Morawe, European Synchrotron Radiation Facility (France)

Conference Program Committee

Lucia Alianelli, Diamond Light Source Ltd. (United Kingdom)

Lahsen Assoufid, Argonne National Laboratory (United States)

Stefan Braun, Fraunhofer IWS Dresden (Germany)

Shih-Lin Chang, National Tsing Hua University (Taiwan)

Raymond Conley Jr., Brookhaven National Laboratory (United States)

Sultan B. Dabagov, Istituto Nazionale di Fisica Nucleare (Italy)

Christian David, Paul Scherrer Institut (Switzerland)

Hans M. Hertz, Royal Institute of Technology (Sweden)

Keiichi Hirano, High Energy Accelerator Research Organization (Japan)

Werner H. Jark, Elettra-Sincrotrone Trieste S.C.p.A. (Italy)

Yasushi Kagoshima, University of Hyogo (Japan)

George A. Kyrala, Los Alamos National Laboratory (United States)

Carolyn A. MacDonald, University at Albany (United States)

Howard A. Padmore, Lawrence Berkeley National Laboratory (United States)

Ladislav Pina, Czech Technical University in Prague (Czech Republic)

Yuriy Ya. Platonov, Rigaku Innovative Technologies, Inc. (United States)

Seungyu Rah, Pohang University of Science and Technology (Korea, Republic of)

Peter Revesz, Cornell University (United States)

Wa'el Salah, Consultant

Horst Schulze-Schrepping, Deutsches Elektronen-Synchrotron (Germany)

Regina Soufli, Lawrence Livermore National Laboratory (United States)

Stanislav Stoupin, Argonne National Laboratory (United States)

Joerg Wiesmann, Incoatec GmbH (Germany)

Stephen W. Wilkins, Commonwealth Scientific and Industrial Research Organisation (Australia)

Makina Yabashi, RIKEN (Japan) and Japan Synchrotron Radiation Research Institute (Japan)

Kazuto Yamauchi, Osaka University (Japan)

Brian W. Yates, Canadian Light Source Inc. (Canada)

Session Chairs

- 1 Novel Developments
Ali Khounsary, Argonne National Laboratory (United States)
Stanislav Stoupin, Argonne National Laboratory (United States)
- 2 Focusing Techniques
Shunji Goto, Japan Synchrotron Radiation Research Institute (Japan)
Satoshi Matsuyama, Osaka University (Japan)
- 3 X-Ray Mirrors
Ladislav Pina, Czech Technical University in Prague (Czech Republic)
- 4 Metrology
Lahsen Assoufid, Argonne National Laboratory (United States)
Werner H. Jark, Elettra-Sincrotrone Trieste S.C.p.A. (Italy)
- 5 Multilayer Coating
Regina Soufli, Lawrence Livermore National Laboratory (United States)
Yuriy Ya. Platonov, Rigaku Innovative Technologies, Inc. (United States)
- 6 XFEL and Miscellaneous Applications
George A. Kyrala, Los Alamos National Laboratory (United States)